



Activity 4: Buildings as Shielding

Objectives

Students will:

- Tour a fallout shelter or research information about fallout shelters.
- Examine the concepts of buildings as shielding and shelter in place.

Next Generation Science Standards

The concepts in this activity can be used to support the following science standard:

- PS4. Waves and Electromagnetic Radiation.

Common Core State Standards (CCSS)

The concepts in this activity align with the following CCSS English Language Arts Standards for Literacy in History/Social Studies, Science, & Technical Subjects:

- Comprehension and Collaboration: CCSS.ELA-LITERACY.SL.6-12.1
- Comprehension and Collaboration: CCSS.ELA-LITERACY.SL.6-8.2
- Craft and Structure: CCSS.ELA-LITERACY.RST.6-12.4
- Research to Build and Present Knowledge: CCSS.ELA-LITERACY.WHST.6-12.9

The concepts in this activity align with the following CCSS Mathematics Standards:

- CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.
- CCSS.MATH.CONTENT.6.RP.A.3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.
- CCSS.MATH.CONTENT.7.SP.A.1. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.
- CCSS.MATH.CONTENT.HSN.Q.A.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Materials and Resources

- Radiation Protection: Teacher Background Information.
- Vocabulary Materials.
- Emergency Planning and Preparedness Quiz (one per student, pair or group) and teacher answer key.
- Fallout shelter; determine if there is a fallout shelter location in your school or community.
- Fallout Shelters Worksheet (one per student, pair or group) and Fallout Shelters Teacher Answer Key.
- Buildings as Shielding image (one per student, pair or group).
- Student computers with Internet access to: (optional)
 - <https://www.ready.gov/>
 - <https://www.epa.gov/radiation/protecting-yourself-radiation>

- A copy of your school's emergency response plan (optional).

Time

45-60 minutes, not including optional activities or extensions.

Vocabulary

- Dose
- Ionizing radiation
- Radiation
- Radiation exposure
- Radiation protection

Directions

1. Start with a vocabulary activity if students are not familiar with radiation and the terms used in this activity, or provide students with the terms and definitions.
2. Ask students to hypothesize what they might do in the event of an airborne radiation incident. **Explain that these events are rare, but might occur, for example, in the event of a traffic accident if a tractor trailer is carrying materials that may pose a risk, a natural disaster (such as Japan's Fukushima nuclear power plant incident or other historical nuclear power plant incidents), or a terrorist attack. Student answers will vary, but may include going to a basement or other shelter for protection.**
3. Distribute the Emergency Planning and Preparedness Quiz if using it as a pre-test. Have students complete the quiz. NOTE: the quiz can be used as a pre- and/or post-test based on your preference. Review the correct answers after students have completed the post-test. If using the quiz as a learning tool only, let students know the quiz is meant to be a fun way to determine what students know and learn and will not be graded.
4. Explain that the United States and Soviet Union were in a race to develop atomic weapons between 1947 and 1991. This period was known as the Cold War. Many people were fearful of a nuclear attack and many fallout shelters were built during this time. These shelters were designed to protect people from the nuclear fallout should a nuclear explosion occur.
5. Ask students:
 - What is nuclear fallout? **Particles of radioactive debris that fall from the atmosphere following a nuclear explosion. Exposure to gamma radiation is a primary concern because gamma radiation can pass through many kinds of materials, including our bodies.**
 - How does a fallout shelter serve as a form of radiation protection? **It serves as shielding.**
6. Tour or research a fallout shelter. Students may visit a designated fallout shelter location within your school or community or research and tour the Greenbrier Bunker online (also known as Project Greek Island) on the Public Broadcasting Service (PBS)' website: <http://www.pbs.org/wgbh/amex/bomb/sfeature/bunker.html>.
7. Provide students with a copy of the Fallout Shelters Worksheet. Have them answer questions 1–5 while touring or researching a fallout shelter. Review their responses as a class. Internet resources may include the PBS Greenbrier Bunker and the National Archives

and Records Administration (NARA) websites: <http://www.archives.gov/education/lessons/fallout-docs/>

8. Provide students with a copy of the Buildings as Shielding image. Have students examine the radiation dose reduction factors within the two images, answer questions 6 and 7 on the Fallout Shelters Worksheet, and discuss and compare their responses.
9. Asks students:
 - Why do the third floors of the 5-story building and office/apartment building offer more protection than the first and second floors? **Because when the radiation falls and settles on the ground, the first and second floors are closer to the radiation source. Therefore, the third floor offers more shielding.**
 - Why are we not able to completely avoid exposure to radiation? **Gamma radiation can pass through many kinds of materials. Additionally, it is very difficult to completely seal off a building to avoid exposure. Radiation may enter through doors, windows, ventilation systems and other cracks or openings.**
10. Distribute the Emergency Planning and Preparedness Quiz if using it as a post-test. Have students complete the quiz and review the correct answers.
11. Optional extension: Direct students to:
 - Develop a plan with their family in the event of an airborne radiation incident when advised to remain indoors. Resources may include:
 - Ready.gov: <https://www.ready.gov/>
 - Protecting Yourself from Radiation: <https://www.epa.gov/radiation/protecting-yourself-radiation>
 - Review your school's emergency response plan to determine where students should go in the event of a radiation emergency.

Emergency Planning and Preparedness Quiz

Name: _____

Date: _____

The following questions are based on a situation in which an airborne radiation incident occurs. Circle or mark the correct answer. There may be more than one correct response for some questions.

1. If you are not near adequate shelter or if you are directed to evacuate, which direction should you travel? There may be more than one correct response.
 - a. Move in a direction that is downwind or in the airflow of the radiation source
 - b. Move in a direction that is upwind or away from the airflow of the radiation source
 - c. Move away from the radiation source
 - d. Move toward the radiation source
2. If you are inside a home or building, which area(s) offers the best protection? There may be more than one correct response.
 - a. The basement or underground area
 - b. The top floor
 - c. An interior room that is farthest from exterior walls and the roof and has no windows
 - d. The ground floor by a window
3. Which of the following should you have in an emergency kit should this situation occur?
 - a. A battery-powered radio
 - b. Plastic sheeting, duct tape and scissors
 - c. Water, nonperishable food and any up-to-date medications
 - d. A change of clothing
 - e. All of the above
4. If safely possible, before seeking shelter, you should turn off ventilation and heating systems and close any doors, windows, vents, dampers and exhaust fans.
 - a. True
 - b. False
5. If you are in a car and unable to seek shelter in a building, what should you do?
 - a. Close the windows
 - b. Turn on the air conditioner or heater
 - c. Use re-circulating air
 - d. All of the above
6. How might this symbol be helpful in the event of a radiation emergency?
 - a. It would signal that radiation is present in the place where it is posted.
 - b. It would signal that hazardous materials (HAZMAT) are in a package or transport vehicle.
 - c. It would direct me to a safe place to wait in a radiation emergency.



Emergency Planning and Preparedness Quiz: Teacher Answer Key

Correct responses are bolded.

1. If you are not near adequate shelter or if you are directed to evacuate, which direction should you travel? There may be more than one correct response.
 - a. Move in a direction that is downwind or in the airflow of the radiation source
 - b. Move in a direction that is upwind or away from the airflow of the radiation source**
 - c. Move away from the radiation source**
 - d. Move toward the radiation source
2. If you are inside a home or building, which area(s) offers the best protection? There may be more than one correct response.
 - a. The basement or underground area**
 - b. The top floor
 - c. An interior room that is farthest from exterior walls and the roof and has no windows**
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3. Which of the following should you have in an emergency kit should this situation occur?
 - a. A battery-powered radio
 - b. Plastic sheeting, duct tape and scissors
 - c. Water, nonperishable food and any up-to-date medications
 - d. A change of clothing
 - e. All of the above**
4. If safely possible, before seeking shelter, you should turn off ventilation and heating systems and close any doors, windows, vents, dampers and exhaust fans.
 - a. True**
 - b. False
5. If you are in a car and unable to seek shelter in a building, what should you do?
 - a. Close the windows**
 - b. Turn on the air conditioner or heater
 - c. Use re-circulating air
 - d. All of the above

It is best if you close the windows, turn off the air conditioner or heater, and close the vents. However, if you need air or ventilation use air that is re-circulated from within the car.

6. How might this symbol be helpful in the event of a radiation emergency?
 - a. It would signal that radiation is present in the place where it is posted.
 - b. It would signal that hazardous materials (HAZMAT) are in a package or transport vehicle.
 - c. It would direct me to a safe place to wait in a radiation emergency.**



Fallout Shelters Worksheet

Name: _____

Date: _____

Fallout shelters serve as a means of shielding people from nuclear fallout or airborne biological, chemical or radioactive hazards. Answer the following questions.

1. Around what time period or historical events did the federal government recommend fallout shelters in the United States and why?

2. Where are fallout shelters generally located? How does the location help shield, or protect against radiation exposure?



Source: U.S. National Archives and Records Administration

3. What structural characteristics should fallout shelters have to help shield, or protect people against radiation exposure?

4. Are fallout shelters necessary today? Why or why not?

5. If needing to seek shelter in your home, which part of your home would offer the best shielding protection and why?

Use the Buildings as Shielding image to answer the following questions.

6. What is the estimated radiation dose reduction factor of the area you chose in Question 5?

7. Based on your findings, does the location you chose in Question 5 offer the best shielding? If not, which location in your home offers better protection and why?

Fallout Shelters: Teacher Answer Key

1. Around what time period or historical events did the federal government recommend fallout shelters in the United States and why?

Following World War II, political and military tensions and economic competition between the United States and the Soviet Union increased. These tensions, along with the Soviet Union developing and testing nuclear weapons, led to a nuclear arms race between the two countries during a period called the Cold War (1947–1991). With the possibility of a nuclear attack, fallout shelters were developed and “duck and cover” drills became commonplace in the 1950s.

2. Where are fallout shelters generally located? How does the location help shield, or protect against radiation exposure?

Fallout shelters are typically located in the lowermost level or centermost portion of a structure to provide shielding from gamma rays. This might include basements, or other in-ground or below-ground structures, and windowless areas in the center of a home or high-rise building structure.

3. What structural characteristics should fallout shelters have to help shield, or protect people against radiation exposure?

The walls and roof should be thick and dense enough to absorb the radiation given off by fallout particles. The structure should be windowless because windows do not shield against gamma radiation. Windows also produce an additional risk if they break (e.g., during a blast). Some fallout shelters may have their own ventilation system.

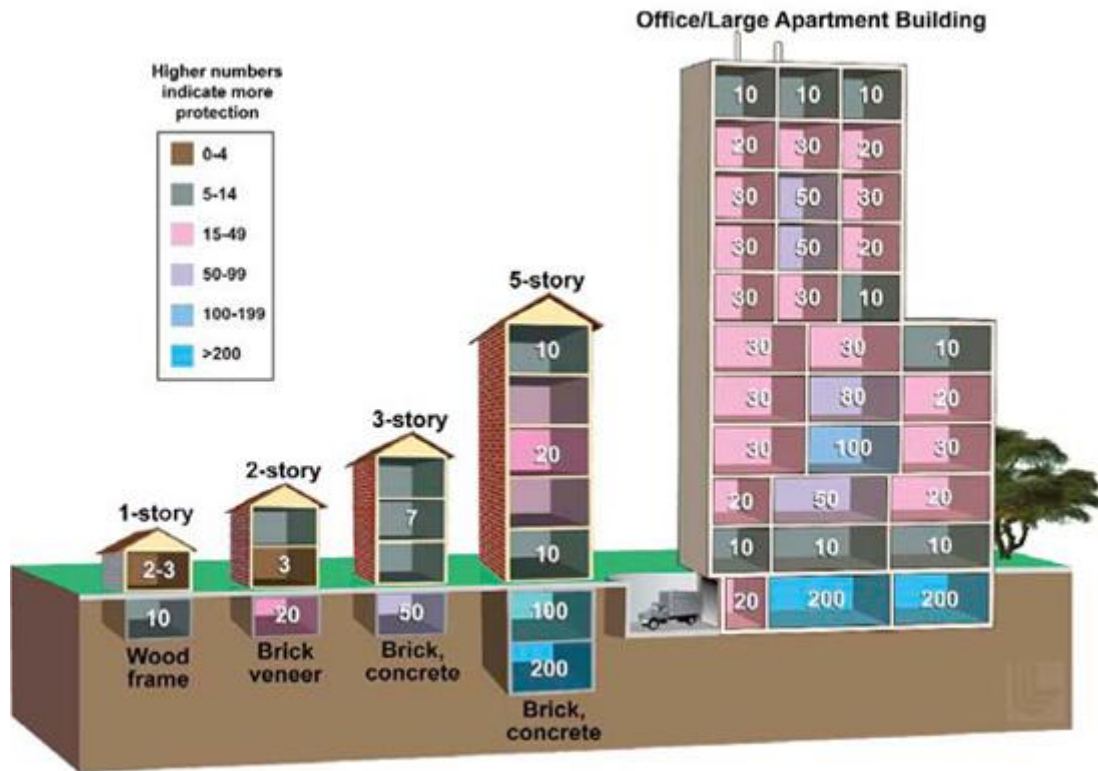
4. Are fallout shelters necessary today? Why or why not?

Fallout shelters serve as a means of shielding oneself from nuclear fallout or airborne biological, chemical or radioactive hazards. Answers will vary based on students' perceived threats of these situations occurring.

Answers for questions 5–7 will be student specific.

Buildings as Shielding

The numbers in the diagram represent a radiation dose reduction factor. For example, the number 50 indicates that a person in that area would receive 1/50th of the dose of a person standing outside of the building. Higher numbers indicate more protection from ionizing radiation.



Source: <https://www.ready.gov/>